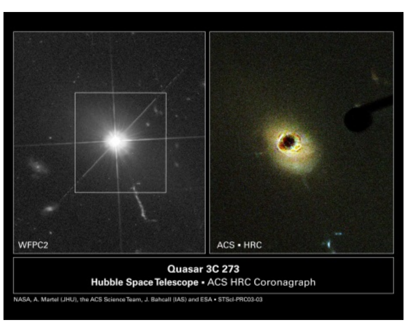
COPAG Science Analysis Group #6
Cosmic Origins Science Enabled by the Coronagraph Instrument
on NASA's WFIRST-AFTA Mission
November 7, 2104

Executive Summary

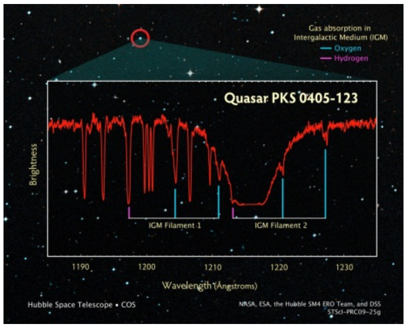
The scientific interests of the Cosmic Origins (COR) Program include supermassive black holes, galaxy formation and evolution, star formation and evolution, interstellar and intergalactic media, and protoplanetary systems. Observations of many interesting processes and structures occur very close to bright objects, and require high contrast imaging or spectroscopic capabilities. Both will be possible with the AFTA coronagraph. Baseline capabilities regarding angular resolution, spatial sampling, field of view of the surrounding dark region, wide-band multi-color photometry, polarization, contrast, and integral field spectroscopy have been defined by the WFIRST-AFTA Science Definition Team. Clear documentation of these coronagraphic capabilities as they mature will allow more detailed planning of COR science investigations.

Coronagraphic requirements for COR investigations differ in some important ways from exoplanet observations that have been used to drive the coronagraph requirements to date:

- Many investigations will not require maximum contrast being implemented for exoplanet science. Efficient ways to achieve contrast near 10^{-6} to 10^{-7} will be valuable.
- Not all of the bright objects will be point sources. Effective means of suppressing the glare of slightly extended objects to approximately 10^{-6} will be useful.
- Narrow-band filters will enhance observations of nebular emission features.
- An integral field spectrograph with a spectral resolution ($\lambda/\Delta\lambda$) of ~3000 (~100 km s^{-1}) would provide diagnostic power for a wide variety of astronomical investigations. This is about an order of magnitude higher resolving power than currently envisioned for exoplanet studies.
- Some of the most interesting astronomical objects are rare, in some cases with only a handful of examples currently known. Surveys with the Wide Field Imager will discover many new examples.



Supermassive black holes are believed to reside in the centers of most galaxies. The nature of the host galaxy environments in the immediate vicinities of the black holes are often poorly understood due to light from the active galactic nucleus. Quasar light is well suited for suppression by a coronagraph, and broad-band imaging will maximize sensitivity to surrounding structures. Morphology, colors and the existence of spiral arms, tidal tails from mergers, roots of jets, and other structures may be revealed. IFS spectra will provide powerful diagnostics of the gas properties and stellar dynamics.



The location and nature of the circumgalactic and intergalactic matter that produces absorption lines in the spectra of distant quasars is largely unknown. These clouds may contain as much as 50% of the matter outside of galaxies, being part of complex structures and cycles of the flows of matter and energy into and out of galaxies. With the quasar light suppressed by the coronagraph, deep broadband images may detect and begin to characterize the faint clouds or dwarf galaxies responsible for the absorption.